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APOLLO MONTHLY PROGRESS REPORT (U)

NAS9-150

February 1, 1964

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Paragraph 8.1, Exhibit I

Report Period

December 16, 1963, to January 15, 1964

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NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

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PROGRAM MANAGEMENT

STATUS SUMMARY

An Apollo spacecraft development test plan, presented to NASA during the report period, was developed by representatives of MIT, Grumman, and S&ID. The plan is based on three concepts: use of "all-up" space vehicles, introduction of block changes, and flexibility in mission and booster assignments. The all-up concept provides for the flying of complete vehicles on each Saturn launch, maximum integrated system flight testing, and a minimum of total development time prior to lunar landing. The introduction of block changes into the program reduces manufacturing, engineering, and test operation effort and allows the incorporation of design improvements into the development program. The major concept, flexibility in mission and booster assignments for each spacecraft, allows the program to be reoriented to accommodate programming changes or to resolve technical issues occurring before launch.

A Pratt & Whitney fuel cell power plant was successfully operated on load at the S&ID engineering development laboratory. This initial test was to determine the capability of the facility to operate fuel cells on load. Further details and an illustration are in the Development section of this report.

The boilerplate 16 service module and adapter were shipped to the Marshall Space Flight Center for installation of micrometeoroid measurement instrumentation. After modification, the service module and adapter will be sent to the Florida Facility for mating with the launch escape tower and command module.

A parachute drop test of boilerplate 19 was successfully conducted at El Centro during the report period, the third in a series of tests under high "q" abort conditions. This was the first time dual drogue chutes have been used in a boilerplate vehicle drop test.

Two test firings of the launch escape pitch control motor were successfully conducted during the report period. These two additional development tests were conducted for further evaluation of the launch escape motors before qualification testing begins in the next report period.

Direction was received from NASA cancelling all engineering, manufacturing, and associated effort on boilerplate 18, pending resolution of the status of the vehicle.

SUPPLEMENTAL AGREEMENT TO CONTRACT NAS9-150

A supplemental agreement is being prepared, incorporating the revision to Article VI of the contract. Article VI provides for final inspection and acceptance of hardware at Downey and determines the level of effort for field site testing operations.

LOGISTICS ENGINEERING

Progress has been made on the preliminary acceptance program and the development of the electronic data processing procedure. The ground support equipment (GSE) planning and requirements document has been distributed.

Supply Support

Revision of spares provisioning documentation to reflect identification and traceability (I&T) requirements has been 80-percent completed. The remaining 20 percent represents supplier items which are held pending resolution of the coding of supplier drawings in consonance with the I&T concept. The report on mechanized site, end article, and total program support status, up-dated and enlarged to reflect spares shipping status, has been rescheduled for the next period. The report will become the Site Support List, providing information to contractor support management and site personnel concerning any facet of the spares support status.

Service Manuals

The major support manual requirements for boilerplates 12 and 13 have been delivered to NASA.

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DEVELOPMENT

AERODYNAMICS

Pressure distributions were analyzed for the command module with launch escape motor during motor burning at various thrust levels for angles of attack of 20, 25, and 31 degrees and at Mach number 1.28. These pressure data were integrated to obtain distributed and total aerodynamic forces needed for structural analysis of the command module.

Subsonic wind tunnel model tests to determine the dynamic stability characteristics of the tower flap configuration subsystems and the command module were completed. The results are being analyzed to optimize the tower flap configuration.

Wind tunnel tests of the 0.105-scale force model in the tower flap configuration were completed at Ames. Static stability data were obtained at Mach numbers 0.5 to 3.4 for the tower flap configuration, the launch escape vehicle, and the command module with scimitar antennas, umbilical, and vent protuberances. These tests completed the tower flap series except for tests at Mach number 10, scheduled for Ames wind tunnel C during the next report period.

MISSION DESIGN

Recent studies show that relocation of the high-gain antenna is required to reduce temperatures caused by impingement from the service module reaction control subsystem (RCS) engines. Consideration was given to the need for the capability of high-gain communication in all spacecraft attitudes during the mission. These attitude requirements include accommodation for optical navigation, thrust and lift vector direction, and positioning of radiation shielding. The study employed new antenna limit plots in place of the previous hemispherical coverage model. Actual signal propagation patterns and characteristics of the infrared earth tracker at various beamwidths were employed. The study indicated that the high-gain antenna should be moved from its present location near the +Y axis to a position 52.25 degrees from the -Y axis towards the +Z axis.

Computer time was reduced approximately 40 percent for powered flight trajectory studies by using an improved numerical integration routine. This represents a significant advance in the development of more efficient and economical powered trajectory computer programs.

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Table 1. ΔV Required for Transearth Injection, Preliminary Results

Conditions						
Feasibility Period	Earth-Moon Distance	Lunar Equator Plane Orientation	Lunar Orbit Stay Time	Transearth Coast Time	Transearth Inclination	ΔV Required* (fps)
Once in several years (absolute minimum ΔV)	Perigee	Most favorable		108 hours	No constraint	2645
100 percent (every day of month)	Apogee	Least favorable	2 days, max	108 hours	No constraint	2700
100 percent (every day of month)	Apogee	Least favorable	2 days, max	84 to 108 hours	No constraint	2840
100 percent (every day of month)	Apogee	Least favorable	2 days, max	60 to 108 hours**	34 degrees to earth equator***	3850

*Not including control allowance for execution of maneuver or evaluation uncertainties.
**Limits vary, depending on time of month, with flexibility of 24 hours on any given date.
***Return to San Antonio, Texas, during half of month; to Woomera, Australia, during other half.

A study is in progress to determine the ΔV required to inject the spacecraft from translunar coast into an 80-nautical-mile circular orbit in the lunar equator plane and to accomplish transearth injection from this orbit. The months of January 1967, May 1969, and June 1971 were selected for investigation by S&ID. Preliminary values of ΔV required for the trans-earth injection are provided in Table 1.

An error analysis was completed for an unmanned Saturn V lunar mission heat shield test trajectory. The analysis assumes availability of an on-board automatic star tracker for platform alignment and a ground operational support system (GOSS) up-data link. The analysis was carried out from the start of the final service propulsion subsystem (SPS) ΔV maneuver to the entry interface.

Two different sets of values for GOSS performance were assumed in arriving at the uncertainties at entry interface shown in Table 2.

Table 2. Uncertainties at Entry Interface

Uncertainties	GOSS Optimistic Performance		GOSS Realistic Performance	
Initial Position	150 feet per axis		1000 feet per axis	
Initial Velocity	1 foot per second per axis		1 foot per second per axis	
Results	Position (feet)	Rate (feet per second)	Position (feet)	Rate (feet per second)
Tangential	800	2.4	3000	3.0
Normal	1000	2.5	4000	2.0
Radial	1200	3.0	4000	3.0

Initial misalignment of the inertial platform was assumed to be 60 arc seconds in both cases. Only the position errors at the entry interface were greatly affected by the more realistic GOSS performance assumption.

CREW SYSTEMS

A 6-pound flight kit is being developed as an aid for in-flight checks and calculations and for manual backup of post-landing location computations.

A microfilm viewer assembly provides the equivalent of 12,000 or more pages of data and information. The kit includes star charts, space almanac, stop watch, sextant, plotting board, logbook, manual computer, and a stylus for recording information.

Phase I of the Apollo manned centrifuge program at the aerospace medical acceleration laboratory (AMAL) was completed during the report period. The tests indicated an interface problem between the couch, the suit, and the astronaut. For example, pressurizing the suit increased the difficulty of seeing the lower part of the instrument panel. The test fixture was disassembled, and the couch, framework, and empty instrument panel are to be shipped to International Latex Corporation, manufacturer of the pressure suit, to serve as a mock-up for study of the interface problem.

STRUCTURAL DYNAMICS

Steady-state and transient aerodynamic pressure tests using the wind tunnel model PSTL-2 in the launch configuration were completed during the report period in the 9-foot-by-7-foot and the 11-foot-by-11-foot wind tunnels at NASA-Ames. The model consisted of the launch escape tower, command and service modules, and the forward portion of the S-IVB booster. 35 transducers were mounted on the model, and approximately 1400 data recordings of steady and transient pressures were made. Steady-pressure data are being integrated to obtain total and distributed airloads. Transient data are being analyzed to determine distribution, amplitude, and frequency of unsteady aerodynamic phenomena. Preliminary data analysis is scheduled to be sent to NASA-MSC during the next report period.

Plans are being implemented to conduct stability tests on a tenth-scale model command module in a random sea condition. The model is the same one used in water drop tests and investigations of stability in sinusoidal waves.

Data from 13 full-scale boilerplate drop tests compared with digital computer program analytical outputs indicate that the structural input data to the mathematical model must be improved before detailed crew couch response accelerations and strokes can be predicted for an actual spacecraft. The requirement for better structural definition applies to both the command module shell and the crew couch struts. This comparison also indicates that very small changes in landing parameters (velocities, attitudes, and soil conditions) have a large effect on couch characteristics and an important bearing on the ability of the computer program to predict results of an actual test.

STRUCTURES

A "rose petal" actuating concept for the S-IVB adapter panels was adoped at an engineering review board held December 12. This configuration comprises four panels hinged at the lunar excursion module support interface line. Means of actuating and holding the panels open are being investigated.

Tooling problems were encountered in the forming of the service module heat shield aft bulkhead. Use of the electro-form process should resolve the problems.

A comparative study was completed of aluminum 2024-T86 and 7178-T6 for the S-IVB adapter shell, using new thermal data. With 2024-T86, the minimum weight was achieved with 465 F outside face sheet temperature, 0.016-inch face sheets, and 0.01-inch cork insulation. With 7178-T6, minimum weight was achieved with 390 F outside face sheet temperature, 0.014-inch face sheets, and 0.04-inch insulation thickness. Use of 2024-T86 is proposed because it has allowables which are less sensitive to temperature changes in the operating range. Weights of the two systems are about the same.

FLIGHT CONTROL SUBSYSTEMS

Stabilization and Control Subsystem

Wiring diagrams for boilerplates 14 and 22 and for spacecraft 006 and 009 were revised to conform to the latest stabilization control subsystem (SCS) configurations. The SCS procurement specification revision and top specification drawing revision were released to the subcontractor. Initial release of the 15 component specification drawings was made.

Preliminary procurement specifications were completed for the unmanned suborbital mission (spacecraft 009), SCS ground control command console, airborne control programmer, and airborne attitude reference system instrumentation package.

Modification of the SCS minimum-impulse circuitry was started to provide more reliable and precise operation. The poppet motion sensing circuitry, which employed a sensor signal to close the control valve, was replaced by a transistor circuit which supplies a pulse to open the valve and allows the valve to close when the pulse falls.

The circuit to shut off the reaction control subsystem (RCS) jets in case of a driver amplifier failure is being tested. This circuit is designed to prevent the occurrence of a runaway engine emergency.

The engineering design change proposed, to raise the minimum roll rate capability during entry from 17 degrees per second to 20 degrees per second, was revised to indicate the method. The rate increase is to be accomplished by raising the amplitude limit of the guidance and navigation (G&N) command signal.

Electronic Interfaces

A method of automating the recording of connector pin assignments and associated functions on specification control drawings was devised. Automation will produce substantial time savings.

The development verification testing procedure for the special purpose connectors between the command module wiring and electronic equipment in the lower equipment bay was approved. Testing began December 17. The connector molds are being reworked to provide connector bodies that will accept retractable center screw hardware. The retractable screws will permit the electronic units to drop into place before the connectors are mated during installation.

Flight Subsystem Analysis

A study to determine the adequacy of the present command module RCS specification and the compatibility of the RCS with other entry flight subsystems was completed for the automatic modes of entry. Preliminary results indicate that the maximum total burn time, excluding propellant dump, was 137 seconds for the roll engine during a lunar return entry; the maximum number of duty cycles was 2523 for the roll engine during earth orbital entry; the longest single pulse was 60 seconds for the yaw or pitch engine during a high-altitude abort. The total burn time determined in the study is not consistent with the present specification requirement of 100 seconds to provide for a single RCS entry condition. Changes in the design of the RCS engine and its related flight subsystems, or in the engine specification, are being investigated as possible solutions.

TELECOMMUNICATIONS

Communications

A review of the operational compatibility of the unified S-band equipment at a meeting in Houston, on December 9 and 10, resulted in a plan of action to revise the equipment. The revised requirement is for continuous range or Doppler tracking. Study and resolution of the impact of the altered operational requirements is in progress.

Instrumentation

Data measurement requirements for spacecraft 006 were published during the report period. The equipment list was released, and procurement was started for 91 percent of the sensor requirements.

Measurement requirements of spacecraft 008 were reviewed to reassess the need for each measurement. This assessment showed that 634 of the 1727 R&D measurements presently planned for the spacecraft may be eliminated. No change was suggested for the 1450 operational measurements (including 963 GSE test points not requiring sensors) as a result of this review.

General procurement specifications, to request vendor quotations, were completed and released for vacuum sensors and for resistance temperature sensors of three types: surface, closed probe, and open probe.

ENVIRONMENTAL CONTROL SUBSYSTEM

A design review of the carbon dioxide measurement subsystem is scheduled for January with S&ID, NASA, Grumman, and Perkins-Elmer participating. This system monitors the CO_2 level in the environmental control subsystem (ECS) suit circuit. The meeting will establish design criteria for the production subsystem units and incorporate changes resulting from development testing of the prototype units.

The analysis of condensation related to the boilerplate 13 cooling subsystem, considering insulation and ambient air conditions at Cape Kennedy, was completed. This analysis indicates that condensation will occur on some parts of the cooling subsystem unless the ambient air is rigorously controlled.

The radioisotope prototype heater source for the service module thermal control subsystem was received. This prototype consists of 972 curies, producing approximately 28 thermal watts.

A preliminary analysis of 32 concepts for spot shielding in the command module was completed. This shielding would reduce the radiation dose received through the area between the windows. Three concepts were considered in detail: relocating the waste and drinkable water storage tanks, relocating the 26 lithium hydroxide canisters, and adding prefabricated polyurethane panels. Analysis indicated that a reduction of 15 to 20 percent can be achieved by relocating water tanks with ideal distribution. Relocation of the lithium hydroxide canisters would result in a 15 percent dose reduction with the canisters in their present shape and a 35 percent reduction if they can be redesigned to a more discoid shape. Adding prefabricated polyurethane panels would result in a 40 percent dose reduction with an increase in weight of 150 pounds.

A thermal analysis was completed of the VHF connector on the +Z scimitar antenna and the coaxial cable from the connector to the first supporting bracket. The analysis concluded that all portions of the cable in or near the connector reach their highest temperatures during a lunar mission reentry trajectory. The central conductor reaches 496 F; the dielectric, 484 F; the braided sheath, 484 F; and the insulation, 482 F. The specified maximum limit for the dielectric and insulation is 482 F sustained temperature, with 527 F permissible for a brief period. Marginal acceptability is indicated.

A thermal analysis of the 1013-wire command-to-service module umbilical in a space environment without the boost cover indicates that steady-state heat leaks are +90 Btu per hour for a hot soak and -150 Btu for a cold soak. With the boost cover the leaks were, respectively, +13 Btu per hour and -92 Btu per hour. In the shaped charge disconnect, maximum and minimum temperatures were 150 F and 0 F without insulation, and 120 F and 30 F with insulation. Recommendations for eliminating the heat leaks in the present design are being formulated.

Cork ablative insulation requirements for boilerplates 13 and 18 were determined for their specific boost trajectories. The cork thickness requirements for some typical locations vary from 0. 09 inches to 0. 16 inches on boilerplate 13, and 0. 12 inches to 0. 18 inches on boilerplate 18.

The ECS compressor is to be redesigned to provide 10 cubic feet per minute to each suit at 3. 5 psia (37 pounds per hour total). This will be accomplished by partially bypassing the lithium hydroxide filter and the activated charcoal filters. The original requirement for 12 cubic feet per minute would require major redesign of the compressor with large weight and power penalities.

ELECTRICAL POWER SUBSYSTEM

The first electrical power subsystem (EPS) delivered hardware from Beech Aircraft was received during the report period, including two oxygen tanks and one hydrogen tank for boilerplate 14. The second hydrogen tank will be shipped in mid-February. The boilerplate 14 tanks are thin-wall vessels and cannot be pressurized. These tanks will be used to verify the electrical portion of the system.

Beech was authorized to proceed with welding the prequalification titanium pressure vessels. Testing of these vessels was started.

Testing of the fan heater units is in progress at Beech. The decision on the use of fan heaters will be made during the next report period.

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Three prototype-A fuel cell power plants were received at S&ID on December 19 (see Figure 1). The fuel cell test stand installation was closely supervised to insure optimum system operation for power plant checkout and evaluation. Preliminary test procedures were detailed and checked out through simulated runs prior to testing.

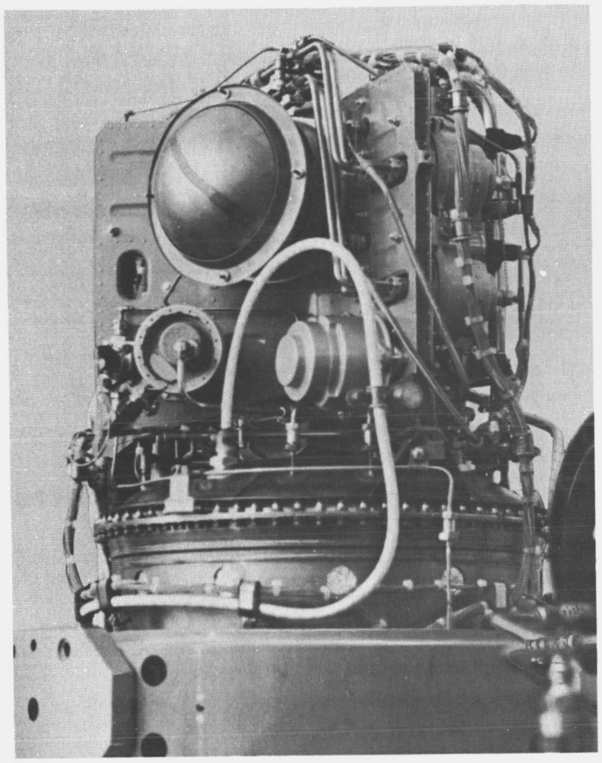

Figure 1. Prototype-A Fuel Cell Power Plant

On January 15, the first fuel cell module was started and put on load. The module operated normally, and all test objectives were accomplished. Total operating time was 4 hours 6 minutes, with 1 hour at each of four loads—20, 30, 40, and 50 amperes. The fuel cell was shut down without incident, and approximately 1500 cubic centimeters of water were collected. The module will undergo further testing.

Westinghouse completed all development tests on the static inverter except short circuit current sensing and operation with half-wave single-phase loads. The specification control drawing for static inverter procurement was revised to include acceptable deviations requested for the first delivered units.

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Power subsystem checkout tests on boilerplate 21 revealed that the electrosolids static inverter, utilized as a coolant pump motor power supply, caused a dc main bus ripple voltage in excess of allowable limits for NASA instrumentation. A line filter will be tested as a fix to reduce ripple. The same problem exists in boilerplates 13 and 15.

The thermal network describing passive cooling of the battery blocking diodes was modified to include the shelf-mounted sensing assembly and overload relay. These components were considered to be thermally isolated from the shell by a 0.01-inch-thick plastic insulation strip. A computer run showed that the components reached maximum temperatures of 190 F and 172 F with this mounting configuration. These temperatures were safely below the maximum operating temperatures of 200 F for the sensing assembly and 185 F for the overload relay. The temperature-time profile of the battery blocking diodes was only slightly affected by these changes and remained well within allowable limits.

The spacecraft 009 emergency detection subsystem schematic diagram is being completely redrawn to conform to new requirements from NASA.

Engineering evaluation of readily available circuit breakers was initiated to determine whether they will function satisfactorily under lunar mission conditions. The circuit breakers will be subjected to a 100-percent oxygen atmosphere and 78-g shock.

PROPULSION SUBSYSTEM

Service Propulsion Subsystem (SPS)

Process specifications were completed for SPS test fixture fill and drain procedures and for SPS engine handling and preparation for service and storage.

Temperature tests of the SPS utilization and gauging equipment were completed, and the results indicated that environmental limits for the electrical control unit range from 30 F, minimum, to 105 F, maximum. Temperature excursions from -100 F to 100 F are predicted in the present location; for this reason, relocation of the unit is being investigated.

A successful development endurance test on the airborne helium tank fill coupling was completed. Problems of excessive torque were resolved by plating the threads with graphite.

Fabrication of the design verification test units for the SPS propellant heat exchanger is nearing completion. A propellant tank door with flight configuration distribution lines is ready for structural tests.

Engineering design of SPS propellant slosh baffle kits is in progress. The plan is to design and manufacture the kits for retro-fit installation in affected spacecraft if propellant motion studies (to be conducted concurrently) indicate that the baffles are needed. This plan will maintain present spacecraft schedules.

In the injector development program 60 firings were accomplished at Aerojet. Pattern modifications are being continued in order to obtain a completely stable injector without baffles. Table 3 lists all firings during this period.

Results from AEDC tests show that space performance with the high-expansion-ratio nozzle approaches shifting flow calculations, indicating that Aerojet may fulfill the specification requirements for engine space performance.

Reaction Control Subsystem (RCS)

Two RCS helium tanks were completed by Menasco, and development test results were found acceptable.

Design verification proof pressure testing of the 0.25-inch pyrotechnic valve is progressing. Successful explosive atmosphere and vibration testing of three units was completed.

The command module RCS engine which showed 15-percent decay in chamber pressure in firings at AEDC is being retested at Rocketdyne to find the cause. Water flow tests showed nothing abnormal. A 3-second firing is planned to obtain chamber pressure data for comparison with the results obtained at AEDC.

Four command module RCS engines for use at AEDC successfully passed the hot firing portion of the acceptance tests at Rocketdyne. Post-firing inspection showed that valve seat leakage rates exceeded specification limits, but these rates are acceptable for the test program.

Launch Escape Subsystem (LES) Motors

The launch escape motor, pitch control motor, and tower jettison motor of boilerplate 12 are undergoing final inspection prior to shipment during the next report period. The tower jettison motor is the latest configuration, having the modified nozzle throat, 33-bolt hole forward attachment flange, and 0.75-inch cartridge thread size. The LES motor propellant will consist of a 31-percent ground oxidizer level to meet specifications.

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Table 3. Injector Development Test Program, Apollo SPS Engine

Serial Number	Type of Pattern	Type of Evaluation	Number of Firings	Number of Unstable Firings	Total Time (sec)	Remarks
AX-1	POUL-31-28	Pattern evaluation	6	2	25.0	
		C*	4	1	17.0	
AX-2	POUL-41-12	C*	5	2	17.0	3-inch baffles
AX-3	POUL-41-10	C*	3	3	1.5	
AFF-20	POUL-31-10	Low-temperature propellant condition	1		472.3	Burned hole through chamber wall
AFF-50	POUL-41-34	C*	3		15.0	Satisfactory
		Incremental duration	3		255.0	Gouging and streaking
AFF-54	POUL-31-10	Alternate materials evaluation	4		298.0	Satisfactory
AFF-61	POUL-31-37	C*	16	2	71.0	
		Incremental duration	4		653.0	
		Injector-chamber compatibility	6		400.0	Streaking
BF-16	POUL-41-16	C*	2	1	8.0	Eroded hub and baffle
00006	Engine assembly	Acceptance test	5		27.0	
AFF-12	POUL-31-31	C*	3		17.0	Satisfactory

*Characteristic exhaust velocity

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Use of a tin-covered lead disc for the hermetic seal of the jettison booster igniter cartridge is being investigated because of a problem that developed in producing the stamped seal. Test results indicate that delivery schedules will be met.

All scale batch-control motors cast from the same batches as launch escape motors ED-30, ED-31, ED-33, and ED-34 were fired. Data from these firings and from full-scale firings of motors ED-27 and ED-28 will determine whether Lockheed is ready to start qualification testing.

DOCKING AND EARTH LANDING

Drop tests 60, 61, and 62 were performed with boilerplate 2 to determine critical impact loads at a horizontal velocity of 0 and a vertical velocity of 24 feet per second, with pitch angles of 30, 20, and 10 degrees. Accelerometer data were satisfactory, but transducer failures prevented full use of pressure data. The heat shield was damaged on drop 62 and must be replaced before further tests are conducted.

Drop test 9 of the command module for boilerplate 19 was conducted with dual drogue parachutes on December 18, and damping was significantly better than with the single drogue. In addition, actual damping (±5 degrees) was better than that predicted (±25 degrees). A study is under way to change the analytical model to approximate actual dynamics more closely.

All details were released regarding modification of boilerplate 6 for multiple drop tests, and the installation drawing was prepared.

Fabrication of the LES sequencer for boilerplate 13, the first Apollo test vehicle for earth orbit, was completed. The sequencer passed bench tests and was delivered on schedule.

GROUND SUPPORT EQUIPMENT

A study was completed to determine utilization of special test units (STU) and necessary variation of the basic STU configuration to meet the needs of each test facility and each spacecraft scheduled. The study, initiated as a result of an S&ID-NASA meeting at Houston, considered the facilities at WSMR, AMR, and S&ID.

The preflight acceptance of the spacecraft checkout equipment (PACE SC) breadboard at AMR was completed, with delivery of response system breadboard 1.

Detail design was started for the cable and junction box models required to support boilerplate 14. The cable design is based on cables having a blown jacket or heat-shrinkable covering. Initial releases were made for 20 standard cabinets to be used in the junction box set.

The GSE models listed in Table 4 were completed and accepted by NASA.

Table 4. GSE Models

GSE Equipment	Boilerplates	
	12	13
Pyrotechnic initiators	X	X
Pyrotechnic bench maintenance equipment	X	X
Launch vehicle substitute	X	X
C-band radar transponder	X	X
Signal conditioner	X	
Antenna checkout group	X	
Test conductor group	X	
Data recording group	X	
On-board recorder checkout	X	
Launch control group		X

Letter contracts were issued to subcontractors for hydrogen and oxygen cryogenic storage subsystems bench maintenance equipment (BME), central timing equipment, SCS card tester, and up-data BME.

SIMULATION AND TRAINERS

"Definition and Configuration for Simulators" was published during this report period. The document is a compilation of mission and configuration concepts for the two simulation complexes incorporating Apollo prototype spacecraft hardware in the man-computer simulation loop. It develops the general capability requirements of the simulator, considering the study-objective and program constraints, and discusses individual functions and hardware in relation to the whole. The information presented is to provide the basis of specification performance and configuration of the engineering simulators.

Air conditioning ducts, ground systems, and rough-wall construction of the facilities were completed for installation of the engineering simulators in the computer-simulator center at S&ID. The area consists of several rooms to house the command modules, simulator controls, visual systems, data acquisition system, and support areas. Facilities fabrication and modification are proceeding on schedule.

PROJECT INTEGRATION

The S&ID flight report on boilerplate 6 was submitted to NASA during the report period. Three major problems require remedial steps to improve future flight reports:

1. Attitude and trajectory data were based on measurements by the on-board gyros, and preliminary trajectory data were furnished by the range. Attitude and final trajectory data were not received by S&ID until 35 days after the flight.

2. Tracking cameras failed to obtain coverage of main parachute actions from initial deployment through full inflation.

3. Some still photographs requested by S&ID either were not received or were of poor quality.

Many other items concerning technical coverage, data, quality, and format require improvement. S&ID is taking necessary action to improve future flight reports.

VEHICLE TESTING

Boilerplate 12 is being prepared for the integrated systems and electromagnetic interference tests to be performed concurrently. The service and command modules were stacked, and the launch escape tower is now being installed. The GSE was connected and checked out simultaneously with the stacking operation, so that testing can start as soon as alignment is adjusted. Upon completion of the concurrent tests, weight and balance operations are to be performed; then the stack will be dismantled and shipped to WSMR for flight test.

The boilerplate 13 GSE integrated tests are approximately 65 percent complete, to be concluded during the next report period. Boilerplate 13 integrated systems tests will begin upon completion of the necessary electrical hookups. Present engineering changes will be incorporated prior to the scheduled January 29 starting date of the integrated systems tests, with the following two exceptions:

1. The escape tower feet for the single-mode bolt separation will not be available until January 22. The conversion from dual mode to single mode will be phased in at the most convenient time.

2. The NASA-designed pressure transducer mounts, as presently delivered, must be modified for compatibility with boilerplate 13 structure prior to installation. The transducer mounts must be available for installation 24 hours before the integrated systems tests begin. Modification of NASA-furnished mounts may not be completed in time to meet the current test schedule.

Boilerplate 15 predelivery test preparations are to be started after the design engineering inspection (DEI) scheduled for January 30. This is the second of two vehicles instrumented to verify launch environment parameters and to perform an earth-orbital mission.

The boilerplate 23 DEI is scheduled for January 29. Because the same GSE is to be used for boilerplates 12 and 23, the integrated systems tests on boilerplate 23 cannot start until boilerplate 12 is shipped.

RELIABILITY

A preliminary statistical study was completed on Space Ordnance Systems initiators to determine the optimum bomb size and pressure tolerances at discrete temperature and vacuum levels. The study includes a review of the proposed Space Ordnance test plan and an evaluation of the statistical approach used. The study indicates that an excessive number of initiators would be expended for engineering development. A statistically designed test plan, with analysis of variance, was proposed by S&ID. It would reduce the number of initiators by 50 percent and result in more information.

A preliminary design review of the survival equipment, medical equipment, personal communications, and bioinstrumentation was completed. Temperatures in the left- and right-hand crew couch medical storage areas may exceed 75 F and cause the deterioration of some drugs originally considered. Any such medicines are to be replaced by others with stability at 150 F of at least 96 hours. Previous space missions of limited duration and distance did not require development of a comprehensive new test program for medical supplies. Items for the first-aid survival and emergency medical kits to be used on Apollo missions will be tested to ensure that they retain their effectiveness when subjected to the worst environmental conditions, such as 100-percent oxygen, 0 to 5 psia pressure, and 0 to 150 F temperatures.

A preliminary design review of the cryogenic gas storage system was approved subject to the satisfactory resolution of the following items:

1. Elimination of a failure mode that could prevent manual override control of the heaters in the oxygen tanks. This failure could result from an open circuit breaker in one of the motorized selector switches in the ECS control box.

2. Clarification of the cleanliness specification requirements, including definition of requirements for on-site replacement of components.

3. Elimination of a discrepancy that exists regarding evacuation rates for the liquid hydrogen system. The current requirement is that the liquid hydrogen be evacuated in 10 minutes; the present system, including GSE takes 15 to 20 hours to drain.

TECHNICAL OPERATIONS

S&ID was authorized to provide six sets each of crew couches and supporting struts, crew couch padding, and crew restraint systems to be installed in two mission simulator trainers.

Refurbishment of static launch escape test tower 2 is planned so that it can be used as the spacecraft 006 LES tower. This task will be accomplished after spacecraft 007 has completed its mission and after spacecraft 006 has undergone acoustic and vibration testing.

A breakwire is to be installed across the pilot and drogue parachute mortars on boilerplates 12 and 23 to provide positive physical monitoring of deployment. The change requires allocation of telemetry channels for the added function and additional wiring between the mortars, the signal conditioner, and the telemetry equipment.

Detailed definitions and objectives for boilerplate 22 and spacecraft 007 were completed.

OPERATIONS

DOWNEY

Boilerplate 12

The spare Q-ball for boilerplate 12 has been installed, and installation of the pressure transducers completed. Rework of the pressure system tubing and its connection to the transducers has also been completed.

The application of the cork ablative material to the command module and forward and aft heat shields of boilerplate 12 has been completed. The boilerplate aft heat shield has been installed on the command module.

Boilerplate 13

Installation of the boilerplate 13 mission sequencer has been completed. The environmental control subsystem (ECS) accumulator has been repaired and installed. Repairs for the omni-antennas have been completed for boilerplates 13 and 15.

The weight, balance, and determination of c.g. was completed for the boilerplate 13 command module, service module, and adapter in the inert condition. The move of the command module, service module, and adapter to the static test tower has been accomplished and the stacking operation is complete. Integrated systems checkout will be performed on the modules while they are in the stacked position. The command module dummy airvent and ECS insulation have been installed in preparation for the reinstallation of the aft heat shield. The dummy scimitar antennas have also been installed, and the service module C-band antenna checkout is complete.

The telemetry ground station is now operational and will support testing of boilerplate 13.

WHITE SANDS MISSILE RANGE

Propulsion Systems Development Facility

The mounting of test fixture F-2 on the propulsion systems development facility (PSDF) test stand 1 has been completed. Firex system testing has been completed. Installation of J-boxes for the PSDF test stand ground support equipment, terminal room, and control center has also been accomplished. Moving and installation of equipment for the meter room have been completed for the temporary location.

FLORIDA FACILITY

The final report for Phase I of Operation Scramble, a simulation of the spacecraft off-loading operation at the Florida Facility, was completed and released. Phase II of Operation Scramble requires NASA participation; a plan of action has been formulated.

The PACE breadboard digital test monitor system (DTMS) has been received, and acceptance testing has begun. The coaxial connectors have been installed on the data lines to the computer room, and cabling runs are being set up between the digital test command systems and the DTMS. The up-link breadboard has been reassembled. This final configuration will be incorporated in the documentation of the NASA up-link breadboard program.

APPENDIX

S&ID SCHEDULE OF APOLLO MEETINGS AND TRIPS

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S&ID Schedule of Apollo Meetings and Trips
December 16, 1963, to January 15, 1964

Subject	Location	Date	S&ID Representatives	Organization
Honeycomb core allowables testing	Berkeley, California	December 16	Spencer	S&ID, Hexcel Products
GSE common usage meeting	Houston, Texas	December 16	Schauers, Corvese, Crouch, Donaldson	S&ID, NASA
Engine propellant combustion reactions discussion	Houston, Texas	December 16	Svenson	S&ID, NASA
Discussion, observation, and evaluation of Avco's proposal for the government-funding of additional facilities	Boston, Massachusetts	December 16	Dieterle	S&ID, Avco
Honeycomb core test methods investigation	Berkeley, California	December 16	Waldron	S&ID, Hexcel Products
Vibration measurement system evaluation	Seattle, Washington	December 16	Ullery	S&ID, Boeing
Apollo fuel cell radiators, technical discussions	E. Hartford, Connecticut	December 16	Snyder, Brenza, Shupack	S&ID, Pratt & Whitney
Apollo mission simulator criteria	Houston, Texas	December 17	LaFrance, Clancy	S&ID, NASA
AGAP acceptance test procedure review	Minneapolis, Minnesota	December 17	Campbell	S&ID, Honeywell
Checkout work group meeting	Cambridge, Massachusetts	December 18	Allen, McKown, Secrist	S&ID, MIT
NAA drawing procedures discussion	Binghamton, New York	December 18	Finley	S&ID, General Precision
TVC servoamplifier design review	Minneapolis, Minnesota	December 18	Witsmeer	S&ID, Honeywell
MSFC control functions discussion	Houston, Texas	December 18	Stone	S&ID, NASA, USAF
Dynamic stability wind tunnel tests consultations	Mountain View, California	December 18	Bornemann	S&ID, Ames
Crew equipment briefing	Binghamton, New York	December 18	Brewer, Hunter	S&ID, Link
IMCC interface information exchange discussion	Houston, Texas	December 18	Kitakis, Schiffman	S&ID, NASA
HL-1C and H-11 pretest conference	Houston, Texas	December 18	Biss, Emerson	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
December 16, 1963, to January 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Project coordination	Minneapolis, Minnesota	December 18	Miller, Lee, Watson	S&ID, Honeywell
Thrust mount stiffness meeting	Sacramento, California	December 18	Cadwell, Dupaquier, Tutt	S&ID, Aerojet-General
Operation center display techniques information	Omaha, Nebraska	December 18	Murken	S&ID, SAC
Boilerplate 13 facility preparation	Cocoa Beach, Florida	December 21	Fairbanks	S&ID, Florida Facility
Facility survey	Denver, Colorado	December 26	Kerr	S&ID, Comcor
Apollo docking simulation studies discussion	Denver, Colorado	December 26	Robertson, Peterson	S&ID, Martin
Resolution of problem areas and ATP review	Minneapolis, Minnesota	December 26	Gibson, Pimple	S&ID, Honeywell
Boilerplate 19 modification	El Centro, California	December 27	Brayton	S&ID, NASA
Incorporation of Engineering orders into Boilerplate 19	El Centro, California	December 27	Bean	S&ID, USN
Pyrogen firing results inspection	Elkton, Maryland	December 29	Yee	S&ID, Thiokol
Engine acceptance test data review	Sacramento, California	December 30	Ross, Borde, Cadwell	S&ID, Aerojet
Preliminary design review meeting	San Carlos, California	January 2	Lanager, Lazarus, Burge, Sztukowski	S&ID, Pelmec
Cost negotiations	Sacramento, California	January 2	Melink, Goodzey	S&ID, Aerojet
AEDC RCS engine tests	Tullahoma, Tennessee	January 2	Reitz	S&ID, Arnold
Schedule [illegible] problems review	Minneapolis, Minnesota	January 2	Antletz, Stiles	S&ID, Honeywell
Apollo development test plan presentation	Houston, Texas	January 2	Ryker, Paup, Sherman, Bell, Jacobson, Graham, Clary, Rider, Perkins	S&ID, NASA
Ground support equipment negotiations	Sacramento, California	January 2	Briggs, DeVries	S&ID, Aerojet
FS-3 wind tunnel tests	Tullahoma, Tennessee	January 2	Daileda	S&ID, Arnold

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S&ID Schedule of Apollo Meetings and Trips December 16, 1963, to January 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Dynamic stability tests	Mountain View, California	January 2	Takvorian, Udvardy	S&ID, Ames
Resolution of waste management technical problems	Bayshore, New York	January 2	Keith, Mann, Nelson	S&ID, Fairchild-Stratos
Expedition of critical items used on Boilerplate 13 and subscale 001	Davenport, Iowa	January 2	Scott	S&ID, Bendix
SPS spacecraft facility test program conference	Tullahoma, Tennessee	January 2	Koppang, Hackett	S&ID, AEDC
RCS engine tests	Tullahoma, Tennessee	January 3	Brandel, Gunter, Rivera	S&ID, AEDC
Downey and AMR PIA activities coordination	Cocoa Beach, Florida	January 3	Eckmeier	S&ID, NASA
Dynamics stability program review	Sacramento, California	January 3	Field, Ress	S&ID, Aerojet-General
Record loss (fire) recovery liaison	Tarrytown, New York	January 3	Hobson	S&ID, Simmonds
Program management meeting	Binghamton, New York	January 6 and 8	Hobson	S&ID, Bell
Proposal design review and field analysis	Woodside, New York	January 5	Matisoff, Augustus	S&ID, Avien
Configuration control implementation	White Sands, New Mexico	January 4	Williamson	S&ID, WSMR
Introduction and residency assignment	Minneapolis, Minnesota	January 4	Babrosky	S&ID, Honeywell
Signal conditioning equipment design review	Cambridge, Massachusetts	January 4	Himmelberg	S&ID, EPSCO
S-band high gain antenna project design review meeting	Woodside, New York	January 5	Matisoff, McCabe, Elston, Ilinski, Ross, Conte, Augustus, Salinger, Barber	S&ID, Avien
Project integration field site representation	Cocoa Beach, Florida	January 5	Gardner	S&ID, NASA
Management meeting	Buffalo, New York	January 5	Hobson, Moore, Whiting, Glavinich	S&ID, Bell
IMCC interface meeting	Houston, Texas	January 5	Flatto, Kitakis, Schiffman, Rogers, Hudelson	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
December 16, 1963, to January 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Cannon test plan discussion	Phoenix, Arizona	January 5	Gibb, Large	S&ID, Cannon
Monthly coordination meeting	Chicago, Illinois	January 5	Bartholomew, Smith	S&ID, Kellogg
Dynamic stability tests	Mountain View, California	January 5	Vardoulis	S&ID, Ames
Supplier PERT effort review	Minneapolis, Minnesota	January 5	Colaianni	S&ID, Honeywell
Engineering conference	Phoenix, Arizona	January 5	Brown	S&ID, Cannon
AMS structural and mechanical design development review	Binghamton, New York	January 6	Hart, Mattei, Erickson, Parkhurst	S&ID, General Precision
Researching and writing the facility-GSE functional verification requirements	White Sands, New Mexico	January 6	Kischer	S&ID, WSMR
PACE breadboard support	Cocoa Beach, Florida	January 6	Warner	S&ID, NASA
Boilerplate 13 engineering support	Cocoa Beach, Florida	January 6	Linsdday, Jackson	S&ID, NASA
PERT procedures and effectiveness review	Minneapolis, Minnesota	January 6	Dyson, Maxwell	S&ID, Honeywell
Management coordination	Melbourne, Florida	January 6	Hagelberg, Pope	S&ID, Radiation
EMI coordination meeting	Minneapolis, Minnesota	January 6	Spiegel	S&ID, Honeywell
Phase-locked oscillator preliminary design review	Davenport, Iowa	January 6	Cunningham	S&ID, Bendix
SPS tank qualification test	Indianapolis, Indiana	January 6	Furman	S&ID, Allison
Monthly coordination meeting	Melbourne, Florida	January 6	Dorrell	S&ID, Radiation
Program review and equipment deliveries finalized, PERT	Mineapolis, Minnesota	January 6	Dyson, Maxwell	S&ID, Honeywell
Dynamic stability tests	Mountain View, California	January 6	Donovan	S&ID, Ames
Pretest conference	Houston, Texas	January 6	Biss, Emerson, Scottoline	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
December 16, 1963, to January 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Design review meeting	Cedar Rapids, Iowa	January 6	Downes, Marine	S&ID, Collins
Management meeting	Buffalo, New York	January 6	Moore	S&ID, Bell
Off-site contractual coverage discussion	Houston, Texas	January 6	Pearce	S&ID, NASA
Off-site work statement discussion	Houston, Texas	January 6	Drucker, Webb	S&ID, NASA
Monthly Apollo facilities construction status and funding review	Houston, Texas	January 6	Malysz	S&ID, NASA
Acceptance test data review	Sacramento, California	January 6	Cadwell, Wolfelt, Ross	S&ID, Aerojet-General
Schedules and manpower freeze discussion	Lowell, Massachusetts	January 7	Lowery	S&ID, Avco
Boilerplate 19 modification	El Centro, California	January 7	Bean, Juarez, Gibbs	S&ID, USN
Boilerplate 22 launch stand umbilical tower interface meeting	San Diego, California	January 7	Martin	S&ID, General Dynamics
Mission planning study	Bethpage, Long Island, New York	January 7	Cole, Myers, Milliken	S&ID, Grumman
Program determination discussion	Lowell, Massachusetts	January 7	King, Boul, Morant	S&ID, Avco
Little Joe II vehicle control meeting and discussion	San Diego, California	January 7	Wolff, Pich, Crowder, Helms	S&ID, General Dynamics
Engineering coordination meeting	Boulder, Colorado	January 8	Frank	S&ID, Beech
Test radiator panels design criteria discussion	Richmond, Virginia	January 8	Miller, Daoussis	S&ID, Reynolds
Management and monthly coordination meeting	Buffalo, New York	January 8	Toomey	S&ID, Bell
Technical and quality assurance coordination meeting	Lima, Ohio	January 8	Nichols, Collins, Griffith-Jones, Ahern	S&ID, Westinghouse
Die tube program evaluation	Richmond, Virginia	January 8	Stefins, Wood	S&ID, Reynolds
Engineering, test, and quality control problems meeting	Lima, Ohio	January 8	Milliken	S&ID, Westinghouse

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S&ID Schedule of Apollo Meetings and Trips
December 16, 1963, to January 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Monthly coordination meeting	Rolling Meadows, Illinois	January 8	Schiavi, Cason, Covington, Forrette, Greenfield	S&ID, Elgin
Project personnel study and results on airframe 008	Houston, Texas	January 8	Foust, Wilkens, McCuen, Palmer, Lundgren, O'Brien	S&ID, NASA
Technical coordination meeting	Rolling Meadows, Illinois	January 8	Traver	S&ID, Elgin
C-band transponder cost negotiation management coordination	Paramus, New Jersey	January 8	Pope, Kronsberg	S&ID, ACF Electronics
Observation of DVT test program completion	San Carlos, California	January 8	Lazarus	S&ID, Pelmec
EMI coordination meeting	Boulder, Colorado	January [illegible]	Carter, Bouman, Kinsinger, Pumphrey, Frank	S&ID, Beech
Budget and financial procedures review	Sacramento, California	January [illegible]	White	S&ID, Aerojet-General
Design review meeting	Woodside, New York	January [illegible]	Webster	S&ID, Avien
Operating procedures review	Las Cruces, New Mexico	January 9	Pearce	S&ID, WSMR
Checkout systems briefing	Houston, Texas	January 10	Cooper	S&ID, NASA
Technical progress on fuel cell development program discussion	E. Hartford, Connecticut	January 12	[illegible]sh	S&ID, Pratt & Whitney
NASA-MIT zero-gravity test observation	Dayton, Ohio	January 12	Spindell	S&ID, Wright-Patterson
Monthly coordination meeting	Indianapolis, Indiana	January 12	Bucuvales	S&ID, Allison
Signal acquisition package design review	Pompano Beach, Florida	January 12	Hardaway, Corder, Wolcott	S&ID, Hoover
Monthly design review meeting	Scottsdale, Arizona	January 12	Covington, Skelton	S&ID, Motorola
Supplier [illegible]lean[illegible]ility and procedures review	Cleveland, Ohio	January 12	Butler, Errington	S&ID, Lear-Siegler
[illegible]ATS-[illegible]MS interface meeting	Houston, Texas	January 12	Kitakis	S&ID, NASA

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S&ID Schedule of Apollo Meetings and Trips
December 16, 1963, to January 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Technical coordination	Scottsdale, Arizona	January 12	Kolb	S&ID, Motorola
Boilerplate 14 technical support	Minneapolis, Minnesota	January 13	Garcia	S&ID, Honeywell
F-1 test stand coordination	Sacramento, California	January 13	Thurman	S&ID, Aerojet-General
GSE systems meeting	Houston, Texas	January 13	Embody, Triay, Wright, Monfort, Siwolop, McMillin	S&ID, NASA
Monthly coordination meeting	Menlo Park, California	January 13	Osborne, Dziedziula	S&ID, Stanford Research Institute
SITL test procedures coordination	Melbourne, Florida	January 13	Hemond, Nourse, Samson	S&ID, Radiation
Interface requirements coordination	Boulder, Colorado	January 13	Carnevale	S&ID, Beech
Interface control documents coordination	Bethpage, Long Island, New York	January 13	Crouch, Richardson, Kolody, Sawer	S&ID, Grumman
Development plan and qualification program on mass flow transducers, discussion	Minneapolis, Minnesota	January 13	Travis, Sokol	S&ID, Rosemount
Television program management briefing	Princeton, New Jersey	January 13	Green	S&ID, RCA
GSE systems meeting	Houston, Texas	January 13	Moore	S&ID, NASA
Engine testing and design activities coordination	Sacramento, California	January 13	Mower	S&ID, Aerojet-General
Engine thrust alignment and service propulsion system coordination	White Sands, New Mexico	January 13	Carr	S&ID, WSMR
SPS engine tests	Tullahoma, Tennessee	January 13	Sheffer	S&ID, AEDC
CSM rendezvous meeting	Boston, Massachusetts	January 14	Hedvig, Davis, Oglevie	S&ID, MIT
NAA centrifuge fixture discussion	Johnsville, Pennsylvania	January 14	Roebuck, Kahn, Opdyke	S&ID, Naval Air Development Center
Static test facility AMR meeting	Houston, Texas	January 14	Hope	S&ID, NASA
Monthly coordination meeting	Indianapolis, Indiana	January 14	Westfall, Bucuvalas, Gardiner, Morse, Olsen	S&ID, Allison

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S&ID Schedule of Apollo Meetings and Trips
December 16, 1963, to January 15, 1964 (Cont)

Subject	Location	Date	S&ID Representatives	Organization
Installation status review	White Sands, New Mexico	January 14	Knoll	S&ID, NASA
Monthly SPS tank technical meeting	Indianapolis, Indiana	January 14	Krainess, Tedisco	S&ID, Allison
Design review procedures negotiations	Houston, Texas	January 15	Bailey	S&ID, NASA
Gemini controls and displays review and discussion	St. Louis, Missouri	January 15	Smith, Hufford, Winkleman	S&ID, McDonnell
Final checkout requirements for SPS propellant utilization and gauging system	Tarrytown, New York	January 15	Stevens	S&ID, Simmonds
Procedure negotiations design review	Houston, Texas	January 15	Rochester	S&ID, NASA

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